525 Rec'd PCT/PTO 08 SEP 2000

FORM PTO-1390 REV. 5-93 US DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE **TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371**	ATTORNEYS DOCKET NUMBER **P00,1566** U.S.APPLICATION NO. (if known, see 37 CFR 1.5) 09/623775

INTERNATIONAL APPLICATION NO. **PCT/DE99/00613**	INTERNATIONAL FILING DATE 8 March 1999	PRIORITY DATE CLAIMED 9 March 1998

TITLE OF INVENTION
"METHOD FOR THE REMOVAL OF ATM CELLS FROM AN ATM COMMUNICATIONS DEVICE"

APPLICANT(S) FOR DO/EO/US
Herbert HEISS and Raimar THUDT

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay.
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of International Application as filed (35 U.S.C. 371(c)(2))
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. §371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).)
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C.371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98; **(PTO 1449, Prior Art, Search Report).**
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included. **(SEE ATTACHED ENVELOPE)**
13. ☒ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:
    a. ☒ Submittal of Drawings
    b. ☒ **EXPRESS MAIL #EJ077700891 US, dated September 8, 2000.**

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U.S.APPLICATION NO (if known, see 37 C.F.R. 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/623775	PCT/DE99/00613	P00,1566

17. ☒ The following fees are submitted:	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 C.F.R. 1.492(a)(1)-(5): Search Report has been prepared by the EPO or JPO . . . . $840.00 International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) . . $700.00 No international preliminary examination fee paid to USPTO (37 C.F.R. 1.482) but international search fee paid to USPTO (37 C.F.R. 1.445(a)(2) . . . . $770.00 Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2) paid to USPTO . . . . $1040.00 International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) . . . . $ 96.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 840.00	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).	$	

Claims	Number Filed	Number Extra	Rate		
Total Claims	8 - 20 =		X $ 18.00	$ .00	
Independent Claims	2 - 3 =		X $ 78.00	$ .00	
Multiple Dependent Claims			$260.00 +	$	
TOTAL OF ABOVE CALCULATIONS =				$ 840.00	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 C.F.R. 1.9, 1.27, 1.28)				$	
SUBTOTAL =				$ 840.00	
Processing fee of $130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$ 840.00	
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). $40.00 per property +					
TOTAL FEES ENCLOSED =				$ 840.00	
				Amount to be refunded	$
				charged	$

a. ☒ A check in the amount of $ 840.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. ____________ in the amount of $ ________ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 501519. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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SIGNATURE

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Registration Number

09/623775

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IN THE UNITED STATES ELECTED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

"PRELIMINARY AMENDMENT"

APPLICANT: Herbert HEISS et al.

SERIAL NO.: EXAMINER:

FILING DATE: ART UNIT:

INTERNATIONAL APPLICATION NO.: PCT/DE99/00613

INTERNATIONAL FILING DATE: 8 March 1999

INVENTION: METHOD FOR THE REMOVAL OF ATM CELLS FROM AN ATM COMMUNICATIONS DEVICE

Hon. Assistant Commissioner for Patents
Box PCT
Washington D.C. 20231

SIR:

Amend the above-identified international application before entry into the national stage before the U.S. Patent & Trademark Office under 35 U.S.C. §371 as follows:

IN THE SPECIFICATION

On page 1, before the title, insert --

SPECIFICATION

TITLE--;

after the title, insert --

BACKGROUND OF THE INVENTION

Field of the Invention--;

in line 3, before "invention" insert --present--;

after line 5, insert --

Description of the Related Art--;

in line 6, replace "pact" with --packet--;

in line 8, before "ATM" insert --an--;

in line 16, delete "Let" and insert --The publication by--;

in line 17, replace "be" with --is--; and

in line 21, delete "thereat" and insert --at the transmission link-- and before "IEEE" insert --publication--.

On page 2, in line 3, before "IEEE" insert --the publication--;

in line 9, before "IEEE" insert --the-- and after "93" insert --publication--;

in line 15, change "accord" to --accordance--, delete "first"and delete "compared to" and insert --before--;

in line 17, after "handled" insert --on a--;

in line 18, after "privileged" insert --basis--;

in line 19, before "IEEE" insert --The-- and after "95" insert --publication--
;

after line 25, insert --

SUMMARY OF THE INVENTION--; and

in line 26, delete "specifying" insert --providing--.

On page 3, in lines 1 and 2, delete "having the features of claim. Developments are the subject matter of the dependent claims." and insert --for removing ATM cells from an ATM communications device wherein ATM cells

are respectively allocated in pluralities to a common frame, all ATM cells of a frame whose first ATM cell is in the waiting list being removed from a waiting list for the administration of a sequence of ATM cells, including the steps of: a frame start identifier is stored that identifies the ATM cell in the waiting list that immediately precedes the first ATM cell of the frame; and the frame start identifier is called before the removal of the ATM cell or, respectively, of the ATM cells of the frame.

In the preferred method, the frame is the frame beginning farthest toward the back in the waiting list. In one embodiment, following ATM cells of the frame up to and including the last ATM cell of the frame are removed upon arrival or following arrival at the waiting list. When the first ATM cell of the frame is immediately preceded by a last ATM cell of a different frame, the frame start identifier references this ATM cell. Alternatively, when the first ATM cell of the frame is immediately preceded by an individual ATM cell not allocated to a frame, particularly an OAM cell or a RM cell, the frame start identifier references this ATM cell. When the fist ATM cell of the frame is followed in the waiting list by an individual ATM cell not allocated to any frame, particularly an OAM cell or ARM cell, a predetermined inhibit value is stored instead of the frame start identifier, so that the ATM cells of the frame cannot be removed from the waiting list. The inhibit value is stored upon arrival of the individual ATM cell at the waiting list and/or when this cell is added to the waiting list according to one development. Preferably, a check is carried out at or following the attaching of an arrived ATM cell to the end of the waiting list to see whether the ATM cell is a matter of a last cell of a frame; and, as warranted, a value that references this ATM cell is stored as the frame start identifier, so that the ATM cells of the appertaining frame cannot be removed from the waiting list.--; and

In line 8, change "I n" to --In--.

On page 4, in line 17, before "frame" insert --a--.

On page 5, after line 15, insert --

BRIEF DESCRIPTION OF THE DRAWINGS--;

in lines 17 and 18, "The individual Figures of the drawing show:";

in line 19, after "Fig. 1" insert --is a diagram of--;

in line 20, after "Fig. 2" insert --is a diagram of--;

after line 21, insert --

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS--;

and

in line 24, change "8,9," to --8 and 9,--; and

in line 29, after "cell" insert --4--.

On page 6, in line 4, change "5, 6" to --5 and 6--.

On page 14, after line 5, add the following new paragraph --

Although other modifications and changes may be suggested by those skilled in the art, it is the intention of the inventors to embody within the patent warranted hereon all changes and modifications as reasonably and properly come within the scope of their contribution to the art.--.

IN THE CLAIMS

On substitute page 15, line 1, change "Patent Claims" to --We Claim:--.

Amend claim 1 as follows:

1. (Amended) A method [Method] for removing ATM cells [(2, 6)] from an ATM communications device wherein ATM cells [(2, 3, 5, 6)] are respectively allocated in pluralities to a common frame [(8, 9)], [whereby] all ATM cells

[(2...6)] of a frame [(9)] whose first ATM cell [(2)] is in a [the] waiting list [(1)] are removed from a waiting list [(1)] for [the] administration of a sequence of ATM cells [(2, 3, 4, 5, 6)], comprising the steps of: [characterized in that]

storing a frame start identifier [is stored] that identifies the ATM cell [(4)] in the waiting list [(1)] that immediately precedes the first ATM cell [(2)] of the frame; and [in that]

calling the frame start identifier [is called] before [the] removal of the ATM cell [(2) or, respectively, of the ATM cells (2, 6)] of the frame [(9)].

2.(Amended) A method [Method] according to claim 1, wherein [characterized in that] the frame [(9)] is the frame beginning farthest toward a [the] back in the waiting list [(1)].

3.(Amended) A method [Method] according to claim 1 [or 2], further comprising the step of: [characterized in that]

removing following ATM cells [(3, 7)] of the frame [(9)] up to and including a [the] last ATM cell [(3)] of the frame [(9) are removed] upon arrival or following arrival at the waiting list [(1)].

4.(Amended) A method [Method] according to claim 1,further comprising the step of: [one of the preceding claims, characterized in that,]

when the first ATM cell of the frame is immediately preceded by a last ATM cell of a different frame, referencing said last ATM cell by the frame start identifier [references this ATM cell].

5.(Amended) A method [Method] according to claim 1, further comprising the step of: [one of the preceding claims, characterized in that,]

when the first ATM cell [(2)] of the frame [(9)] is immediately preceded by an individual ATM cell [(4)] not allocated to a frame, [particularly an OAM cell or a RM cell,] referencing said individual ATM cell by the frame start identifier [references this ATM cell (4)].

6.(Amended) A method for removing ATM cells from an ATM communications device wherein ATM cells are respectively allocated in pluralities to a common frame, all ATM cells of a frame whose first ATM cell is in a waiting list are removed from a waiting list for administration of a sequence of ATM cells, comprising the steps of: [Method according to one of the claims 1 through 5, characterized in that,]

when the first ATM cell of the frame is followed in the waiting list by an individual ATM cell not allocated to any frame, [particularly an OAM cell or ARM cell,] storing a predetermined inhibit value [is stored instead of the frame start identifier,] so that the ATM cells of the frame cannot be removed from the waiting list.

7.(Amended) A method [Method] according to claim 6, wherein [characterized in that] the predetermined inhibit value is stored at least one of upon arrival of the individual ATM cell at the waiting list and [/or] when the individual ATM [this] cell is added to the waiting list.

8.(Amended) A method [Method] according to claim [one of the claims] 1 [through 7], [characterized in that]

performing a check [is carried out] at or following [the] attaching of an arrived ATM cell to an [the] end of the waiting list to see whether the arrived ATM cell is [a matter of] a last cell of a frame; and [in that,]

as warranted, storing a value that references the arriving [this] ATM cell [is stored] as the frame start identifier, so that the ATM cells of the appertaining frame cannot be removed from the waiting list.

IN THE ABSTRACT

Amend the abstract as follows:

ABSTRACT OF THE DISCLOSURE

A [The invention is directed to a] method for [the] removal of ATM cells (2, 6) from an ATM communications device wherein ATM cells (2, 3, 5, 6) are respectively allocated in pluralities to a common frame (8, 9), whereby all ATM cells (2...6) of a frame (9) whose first ATM cell (2) is in the waiting list (1) are removed from a waiting list (1) for the administration of a sequence of ATM cells (2, 3, 4, 5, 6). [In particular, the] The method makes it possible to quickly and efficiently create space for cells having a higher priority in the ATM communications device.

[Fig. 1]

REMARKS

The foregoing amendments to the specification and claims under Article 41 of the Patent Cooperation Treaty place the application into a form for prosecution before the U.S. Patent and Trademark Office under 35 U.S.C. §371. Accordingly, entry of these amendments before examination on the merits is hereby requested.

Respectfully submitted,

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METHOD FOR THE REMOVAL OF ATM CELLS FROM AN ATM COMMUNICATIONS DEVICE

The invention is directed to a method for the removal of ATM cells from an ATM communications device in which a respective plurality of ATM cells are allocated to a common frame.

In a traditional packet communication system, a pact has a comparatively great and variable length. A system for the transmission of information in packets having fixed, predetermined lengths is referred to as ATM (asynchronous transfer mode) system. Voice, video and data signals can be processed and transmitted in the same way with such a system. The individual packets are usually called cells. A cell header, whose information enables a switching or, respectively, allocation of the respective cell is respectively contained in the cells. A high-speed and broadband transmission with a transmission rate of more than 150 Mb/s is possible in ATM communication devices, particularly communication network devices.

In particular, the ATM cells have a length of 53 bytes for a broadband ISDN (Integrated Services Digital Network). Let M. DePrycker, "Asynchronous Transfer Mode", 2nd Edition, London, Horwood, 1993, be referenced for further details about the structure of ATM cells.

One problem given ATM communication devices is the height of the transmission rate on a transmission link of the device when a back-up of ATM cells has formed thereat. The problem is described in greater detail in the IEEE Journal on Selected Areas in Communications, Vol. 13, No. 4, May 1995, pages 633 through 641, "Dynamics of TCP Traffic over ATM Networks" by Allyn Romanow and Sally Floyd (referred to as IEEE 95 below). The article is concerned with ATM systems wherein a respective plurality of ATM cells are allocated to a common frame. When, for example, a cell of such a frame has been lost or damaged, it is undesirable that the further cells of the same frame are transmitted via a transmission link of an ATM device since the complete information of the frame would no longer arrive at the end of the transmission link. The ATM system would be unnecessarily burdened.

Particularly given a back-up on the transmission link, it is therefore important to remove the further cells of the frame as quickly and effectively as possible.

It is therefore proposed in IEEE Network Mag., Vol. 7, No. 5, pages 26 through 34, September 1993, “Packet Reassembly during Cell Loss” by G. Armitage and K. Adams (referred to below as IEEE 93) to remove ATM cells of a specific frame at the respective arrival of an individual ATM cell at the end of a waiting list. In particular, such waiting lists serve for the administration of a sequence of ATM cells at the end and/or at the start of a transmission link. According to the method described in IEEE 93, which is referred to as partial packet discard (PPD below), the first and – when present – further cells of the frame that are already in the waiting list are not removed; rather, only all newly arriving cells of the frame are removed, with the exception of the last cell of the frame. PPD has the disadvantage that at least the first and the last cell continue to remain in the waiting list.

Waiting lists are usually organized according to the FIFO principle, in accord wherewith the cell that arrived first at the waiting list compared to another cell also in turn leaves it first. Under certain circumstances, however, the cells are divided into at least two priority classes, whereby cells of a higher priority are handled privileged.

IEEE 95 discloses another method according to which all cells of a frame, from the first to the last cell are removed from the ATM communication device upon arrival at a waiting list. This method, called early packet discard (EPD below) has the advantage that no residual cells of a damaged frame or of a frame to be removed for other reasons remain, and, thus, the maximally possible space is available for other ATM cells. EPD, however, cannot be applied to frames whose first cell has already been added to the waiting list.

The present invention is based on the object of specifying a method for the removal of ATM cells from an ATM communications device wherein a respective plurality of ATM cells are allocated to a common frame, whereby ATM cells of a specific frame can be removed from the ATM communications device in an optimally short time and in an optimally great plurality of conditions of a waiting list.

This object is achieved by a method having the features of claim 1. Developments are the subject matter of the dependent claims.

What is understood by the term "waiting list" in this specification is any administration unit for the administration of a plurality of ATM cells in which a one-dimensional logical chaining of the plurality of ATM cells is formed or can be produced. Waiting lists that are organized according to the FIFO principle are particularly included here.

In the inventive method for the removal of ATM cells, all ATM cells of a frame whose first ATM cell is located in the waiting list are removed from a waiting list for the administration of a sequence of ATM cells. The greatest possible space in the waiting list is thus created given removal of the ATM cells of the frame. Over and above this, it is possible to remove all ATM cells of the frame simultaneously or immediately successively from the waiting list, so that the cells can be removed in the shortest possible time. In particular, it is not necessary to thereby wait for the arrival of ATM cells at the waiting list. The method can also be applied given a plurality of conditions of the waiting list, namely whenever the first ATM cell of a frame is in the waiting list. Given developments of the method, the application of the method can, however, be made dependent on meeting additional conditions.

When, for example, the waiting list is realized with a pointer chain, the deletion or, respectively, removal of the ATM cells can be realized simply by parting the pointer chain and by releasing the corresponding memory space in a data store. As known, the pointer chain can be produced and administered with a computer program or with hardware, particularly upon utilization of the information at defined locations in hardware data store areas for accepting ATM cell information.

In a development of the method, the frame whose ATM cells are removed is the frame that begins farthest toward the back in the waiting list. Upon removal of the ATM cells of the frame, it is particularly the first ATM cell thereof that is identified, and this ATM cell as well - when present - all following ATM cells of the frame located in the waiting list are removed.

Preferably, following ATM cells of the frame are removed at or following arrival at the waiting list up to and including the last ATM cell of the frame. What this prevents is that the ATM cells of the frame arriving later unnecessarily burden the ATM communications device. The removal of the following ATM cells is the same as the removal of ATM cells according to EPD insofar as the removal of the individual cells is triggered by their arrival at the waiting list.

A frame start identifier is preferably stored that references the ATM cell in the waiting list immediately preceding the first ATM cell of the frame, and the frame start identifier is called before the removal of the ATM cell or, respectively, of the ATM cells of the frame. This procedure has the advantage that the information usually present in ATM systems regarding which cell is the last cell of a frame can be utilized. This information is usually present in the cell header of the last cell of the frame, namely in what is referred to as the AAU bit in the cell type field (payload-type field) of the cell header as a rule.

In particular, the presence of this information is respectively checked at or before the adding of a newly arrived ATM cell to the end of the waiting list. As warranted, a value is then stored as frame start identifier that identifies this ATM cell, so that the ATM cells of the appertaining frame cannot be removed from the waiting list since - at least in this status of the waiting list - no first ATM cell of a following frame is present in the waiting list after the last ATM cell of the frame that has just arrived. As soon as such a first ATM cell of a following frame has arrived, a removal of ATM cells of the following frame is possible.

In particular, the above-described measure serves the purpose of protecting individual ATM cells not allocated to any frame, particularly OAM cells (operation, administration, maintenance) or RL cells (resource management) in a development of the method. OAM cells generally serve for administration and maintenance; RM cells serve for flow control. Such individual cells should often not be removed from the ATM communications device. When such an individual ATM cell immediately precedes the first ATM cell of the frame that is the only frame beginning in the waiting list or is the frame that begins farthest toward the back in the waiting list, a

value that references this individual ATM cell is therefore preferably stored as the frame start identifier. Consequently, this individual cell is protected from being removed because, in this development of the method, only following cells in the waiting list can be removed.

When a last ATM cell of another frame immediately precedes the first ATM cell of the frame that is the frame beginning farthest toward the back in the waiting list, the frame start identifier preferably references this ATM cell.

Another possibility of protecting individual ATM cells not allocated to any frame is realized in a development. In this development, a predetermined block value is stored instead of the start identifier when the first ATM cell of the frame whose ATM cells come into consideration for removal from the waiting list is followed by such an individual ATM cell. The block value is preferably stored upon arrival of the individual ATM cell at the waiting list and/or when this cell is added to the waiting list. The cell is thus immediately protected after it arrives or, respectively, is added.

The invention is now described in greater detail on the basis of exemplary embodiments. However, it is not limited to these exemplary embodiments. The individual Figures of the drawing show:

Fig. 1	a waiting list for the administration of a sequence of ATM cells; and
Fig. 2	the procedure of removing ATM cells proceeding from the status of a waiting list shown in Fig. 1.

Figure 1 shows a waiting list 1 in which ATM cells 2, 3, 4, 5, 6 are arranged in a specific sequence. The ATM cells are thereby partially allocated to two different frames 8, 9, whereby further ATM cells of the frame 8 have already left the waiting list 1 in the direction of the arrow toward the right, and further ATM cells of the frame 9 have not yet arrived at the waiting list 1 (coming from the left). The first waiting list cell 5 is therefore not the first cell of the frame 8. The last frame cell 3 of the frame 8, which carries a corresponding frame end identifier in its cell header, is in the waiting list 1. This last frame cell 3 is immediately followed by an OAM cell that is an individual cell not allocated to any frame. The OAM cell 4 is immediately

followed by the first frame cell 2 of the frame 9. Further ATM cells of the frame 9 follow. One of these ATM cells is the last waiting list cell 6 of the waiting list 1.

Variables, particularly pointers, are provided for marking specific cells 4, 5, 6 in the waiting list 1, particularly with a computer program for the administration of the cells in the waiting list 1. The variable P_first_cell thereby references the first waiting list cell 5 of the waiting list 1. When the waiting list 1 is empty, then a predetermined value is stored in the variable, referred to as "invalid" below, which means that no valid entry is present. A value that references the last ATM cell that is a last frame cell in the waiting list 1 is stored in the variable P_end_of_frame. When such a last frame cell is followed, for example as in Figure 1, by the ATM cell 3, an individual cell not allocated to any frame, the OAM cell 4 in the example of Figure 1, then the identifier of the last cell, i.e. the individual cell located farthest toward the back of the waiting list 1, is stored in the P_end_of_frame. In the example of Figure 1, only one such cell is present, so that P_end_of_frame contains the identifier of the OAM cell 4.

When space is then to be created in the ATM system, particularly for ATM cells having a higher priority, then, as shown in Figure 2, all cells of the frame 9 that are already in the waiting list 1 are initially removed from the waiting list. To that end, the value of the cell that is already entered in the variable P end of _frame is preferably entered in the variable P_last_cell. In the example of Figure 2, this is the OAM cell 4. Further, the value TRUE is preferably entered in a variable LPD_flag. In order to enable a querie as to whether the procedure of the removal of ATM cells is activated. LPD is the abbreviation for last packet discard, which means that the last frame in the waiting list is removed.

Following ATM cells 7 of the frame 9 are then removed at or after the arrival at the waiting list 1. The status shown in the upper part of Figure 2 has thus been reached. The further, following ATM cells of the frame 9 up to the frame end 10, i.e. up to the last ATM cell 3 of the frame 9, are removed at or following the arrival at the waiting list 1. The status of the waiting list 1 shown in the lower part of Figure 2 has thus been reached.

An exemplary embodiment of the invention is now described below on the basis of parts of a computer program for administering a sequence of ATM cells in a waiting list. Such computer programs are also employed in the known methods of early packet discard (EPD) and partial packet discard (PPD). Routines of the computer program described below, however, partially differs significantly from the known computer programs.

The following assumptions are made: ATM cells arrive at a waiting list. Some of these cells as well as cells that are already classified in the waiting list are to be removed. The remaining cells leave the waiting list in the meantime or later. The ATM cells are at least partially organized in frames, i.e. successive ATM cells from a first frame cell up to a last frame cell belong to a common frame. No frame cells of a different frame are located between the first and the last frame cell. However, individual ATM cells not allocated to any frame can be arranged between the first frame cell and the last frame cell. That stated above applies both to the sequence in a waiting list as well as to the sequence of the transmission on a transmission link of an ATM communications device. The last ATM cell of a respective frame can be unambiguously identified. An unambiguous, one-dimensional chaining of the cells is produced in the waiting list for the administration of the ATM cells in the waiting list. The sequence is thus unambiguously defined. For locating specific cells in the waiting list, however, it would last too long if the search were always begun at the beginning or end of the waiting list and the cells had to be checked cell-by-cell in the waiting list. Following cells can therefore be directly located by storing an identifier in a variable:

- the first cell in the waiting list (variable: P_first_cell)
- the last cell in the waiting list (variable: P_last_cell)
- the last cell in the waiting list that is a last frame cell or that is an individual cell not allocated to any frame and that is arranged between two frames (variable: P_end_of_frame).

The removal of ATM cells according to the LPD method is only implemented when the last frame cell of the waiting list is not the cell whose

identifier is deposited in P_end_of_frame and when a valid cell identifier is entered in the variable P_end__of_frame, i.e. when a last frame cell or an individual cell following thereupon is still in the waiting list.

A plurality of waiting lists can be present in an ATM communications device, these being respectively administered according to the method described below. In this case, each waiting list has its own individual identifier, and variables for storing the aforementioned cells are present in each waiting list. For the sake of simplicity, it is assumed for the following program parts that only one waiting list is present.

First, individual operations shall be presented that can be implemented at the cells. It is assumed that each of the cells has an unambiguous identifier that is referenced P_cell. The operations are:

-	*next__cell (P_cell)*	returns the identifier of the immediately following cell in the waiting list.
-	*end_of_frame (P_cell)*	returns the value TRUE when P__cell references a last frame cell and otherwise returns the value FALSE.
-	*exclude_cell (P_cell)*	returns the value TRUE for cells that are not to be removed, for example OAM cells
-	*discard_cell (P_cell)*	removes the cells with the identifier P_cell
-	*decide_cell (P_cell)*	determines on the basis of criteria that are not explained in detail here whether specific operations or procedures, particularly *discard _cell* or *append_cell* (see below) are to be carried out at the cell having the identifier P __ cell.

The following procedures or, respectively, functions (called procedures below) are explained in greater detail:

- *arrive_cell (P_cell)*	implements various operations at the cell having the identifier P_cell upon arrival at the waiting list.
- *queue_empty*	returns the value TRUE when the waiting list is empty and otherwise returns the value FALSE.
- *append cell (P_cell)*	attaches the cell having the identifier P_cell to the end of the waiting list and implements various operations
- *extract_cell*	serves for the removal of a cell at the start of the waiting list, particularly for the transmission of this cell onto a transmission link
- *remove_last_frame*	removes all cells of the last frame of the waiting list from the waiting list, if possible.

In order to enable an inquiry as to whether the removal of cells from the ATM communications device according to the method LPD is active, a boolean variable LPD_flag is provided.

In the initialization of the program, i.e. when the waiting list is empty, the three cell identifier variables P_first_cell, P_last_cell and P_end _of_frame are set to the value "invalid", and the variable LPD_flag is set to the value FALSE.

Cells that are not ordinary data cells and that do not belong to a frame can arrive at the waiting list. These individual cells, for example OAM cells or RM cells, can be excluded from removal from the ATM communications device or can be not excluded therefrom. Criteria that are not explained in greater detail here are available for this purpose in the ATM communication system. When one of these cells that is not to be removed is arranged within a first and a last frame cell, then the removal of the cells of the frame is not implemented according to the method LPD.

Procedure *arrive_cell* works according to the following algorithm in the exemplary program:

```
IF exclude_cell (P_cell)
THEN append_cell   (P_cell)
ELSE IF LPD_flag = TRUE
    THEN IF end_of_frame    (P__cell)
            THEN LPD__Flag = FALSE
            discard_cell   (P__Cell)
    ELSE IF PPD_flag = TGRUE
            THEN IF end_of_frame (P__cell)
                    PPD__flag = FALSE
            ELSE discard_cell     (P__cell)
    ELSE decide_cell   (P__cell)
```

In the procedure *arrive__cell (P_cell)*, a check is first carried out to see whether the cell that has arrived is accepted in every case, i.e. is to be attached to the end of the waiting list. Otherwise, a check is carried out to see whether the removal of cells according to the method LPD is activated. If yes, then the cell is removed and the removal is disabled for following cells if the cell is the last frame cell. When LPD is not activated, then a check is carried out to see whether the method PPD (partial packet discard) known from the prior art is activated. PPD can lead to an unburdening of the ATM system in specific instances when LPD cannot be implemented. In PPD, only cells arriving at the waiting list are removed and no cells already in the waiting list are removed. When PPD is activated, then the cell that has arrived is removed if it is not a last frame cell. When it is a last frame cell, the procedure *append_cell (P_cell)* is called and PPD is subsequently deactivated. When PPD and LPD are not activated, the procedure *decides__cell (P_cell)* is called.

The procedure *append__cell (P__cell)* works according to the following algorithm in the exemplary program:

```
IF          cell identified by P_cell is to be discarded for other reasons
            THEN discard__cell   (P_cell)
            ELSE IF    queue__empty
                        THEN P__first_cell = P__cell
```

```
                    P_last_cell    =  P_cell
          ELSE IF   exclude__cell  (P_cell)
                    THEN IF P_end_of_frame=(P_last_cell)
                            /*both are valid implicitly*/
                            THEN P_end_of_frame = P_cell
                            ELSE P_end_of_frame = invalid
          next_cell (P_last_cell) = P_cell)
          P_last__cell = P_cell
    IF end_of_frame (P_cell)
          /*cell with identifier P_cell is the last cell of the frame*/
    THEN P__end__of__Frame = P_cell
```

In the procedure *append_cell (P_cell)*, a check is first carried out to see whether the cell having the identifier P_cell is to be removed in any case. Potentially, the procedure *discard_cell (P_cell)* is called. Otherwise, a check is carried out to see whether the waiting list is empty. If it is, the identifier of the cell is entered in the variables P_first_cell and P__last_cell. When the waiting list was not empty, a check is carried out to see whether the cell is to be protected against removal in any case because, for example, it is an OAM cell. When this cell is to be protected in every case, either the identifier of the cell is entered in the variable P_end_of_frame (when the identifier of a last frame cell was previously entered in the variable) or the value "invalid" is otherwise entered. When the cell with the identifier P_cell is itself a last frame cell, its identifier is entered in the variable P_end_of_frame. In order to attach the cell to the waiting list, a pointer connection to the attached cell is produced regardless of the previous status of the waiting list and regardless of the nature of the cell to be inserted, and the identifier of the cell is entered in the variable P_last_cell.

The procedure *extract_cell* is described by the following algorithm in the exemplary program:

```
IF          NOT (queue__empty)
THEN IF P_first_cell = P_endd_of_frame
        THEN P_end_of_frame = invalid
```

```
        remove cell identified by P_first_cell from queue for further use
        And retrieve storage
        P_first_cell = next_cell   (P_first_cell)
```

According to the procedure *extract_cell*, the first cell of the waiting list is taken - when the waiting list is not empty - for further processing, particularly transmission, from the waiting list. A check is thereby carried out to see whether the first cell is a matter of a last frame cell or, respectively, a matter of an individual cell entered in the variable P_end_of_frame. In this case, the value "invalid" is entered in the variable P_end_of_frame, since, following the removal of the first cell, a corresponding cell is then no longer located in the waiting list. In particular, a last frame cell is then no longer in the waiting list. A removal of cells from the waiting list is then not possible until a last frame cell and a frame cell of a following frame following thereupon have been attached to the waiting list. The first waiting list cell is removed and the identifier of the next-successive cell in the waiting list is entered in the variable P_first_cell.

The procedure *remove_last_frame* is described by the following algorithm in the exemplary program:

```
IF      NOT
        (queue_empty OR
        (P_end_of_frame = invalid) OR
        (P_end_of_frame = P_last_cell))
        /*last frame can be removed*/
THEN    P_last_cell = P_end_of_frame
        LPD_flag   = TRUE
        retrieve storage starting at cell with identifier
        next_cell   (P_last_cell)
```

Three conditions are initially interrogated in the procedure:

- is the waiting list empty?
- is the value "invalid" entered in the variable P_end_of_frame?
- is the same identifier entered in the variable P_end_of_frame and in the

variable P_last_cell?

When all three questions are answered with no, all cells of the frame that is the frame beginning farthest toward the back in the waiting list are removed from the waiting list. This is achieved in a simple way in that the same value that is entered in the variable P__end__of_frame is entered in the variable P_last__cell. Either the value of a last frame cell or of an individual cell following such a cell thus resides in these two variables. Further, the boolean variable LPD_flag is set to the value TRUE in order to remove following ATM cells of the frame at their arrival at the waiting list up to and including the last ATM cell of the frame. The memory space occupied by the removed cells is released.

In conclusion, the advantages of the method LPD are again summarized:

- complete frames can be removed
- Space is created as fast as possible in a waiting list in that all cells of a frame already in the waiting list are removed from the waiting list either simultaneously or in immediate succession.
- The furthest cells of the frame up to the last frame cell are removed immediately when they arrive at the waiting list.
- The removal of the cells from the waiting list is independent of the arrival of cells at the end of the waiting list. In order to obtain this advantage, only two additional variables are required, namely P_end_of_frame and LPD_flag. Dependent on the type of method that LPD replaces, however, one variable can also be eliminated under certain circumstances. For example, a variable EPD_flag is not required, this indicating whether the method EPD (early packet discard) is activated.
- Particularly individual cells that are not to be removed from the ATM communications device under any circumstances are effectively protected against removal.
- In the described exemplary embodiment, a computer program for administering a sequence of ATM cells of a weighting list manages with a minimum of operations when ATM cells are removed from the waiting

list. New values are only entered in two variables, namely P_last_cell and LPD_flag, and the corresponding memory space is released. The release of the memory space can thereby be particularly implemented step-by-step when free calculating time is available. The system is thus available for further cell operations within the shortest possible time.

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PATENT CLAIMS

1. Method for removing ATM cells (2, 6) from an ATM communications device wherein ATM cells (2, 3, 5, 6) are respectively allocated in pluralities to a common frame (8, 9), whereby all ATM cells (2...6) of a frame (9) whose first ATM cell (2) is in the waiting list (1) are removed from a waiting list (1) for the administration of a sequence of ATM cells (2, 3, 4, 5, 6), characterized in that a frame start identifier is stored that identifies the ATM cell (4) in the waiting list (1) that immediately precedes the first ATM cell (2) of the frame; and in that the frame start identifier is called before the removal of the ATM cell (2) or, respectively, of the ATM cells (2, 6) of the frame (9).

2. Method according to claim 1, characterized in that the frame (9) is the frame beginning farthest toward the back in the waiting list (1).

3. Method according to claim 1 or 2, characterized in that following ATM cells (3, 7) of the frame (9) up to and including the last ATM cell (3) of the frame (9) are removed upon arrival or following arrival at the waiting list (1).

4. Method according to one of the preceding claims, characterized in that, when the first ATM cell of the frame is immediately preceded by a last ATM cell of a different frame, the frame start identifier references this ATM cell.

5. Method according to one of the preceding claims, characterized in that, when the first ATM cell (2) of the frame (9) is immediately preceded by an individual ATM cell (4) not allocated to a frame, particularly an OAM cell or a RM cell, the frame start identifier references this ATM cell (4).

6. Method according to one of the claims 1 through 5, characterized in that, when the fist ATM cell of the frame is followed in the waiting list by an individual ATM cell not allocated to any frame, particularly an OAM cell or ARM

cell, a predetermined inhibit value is stored instead of the frame start identifier, so that the ATM cells of the frame cannot be removed from the waiting list.

7. Method according to claim 6, characterized in that the inhibit value is stored upon arrival of the individual ATM cell at the waiting list and/or when this cell is added to the waiting list.

8. Method according to one of the claims 1 through 7, characterized in that a check is carried out at or following the attaching of an arrived ATM cell to the end of the waiting list to see whether the ATM cell is a matter of a last cell of a frame; and in that, as warranted, a value that references this ATM cell is stored as the frame start identifier, so that the ATM cells of the appertaining frame cannot be removed from the waiting list.

ABSTRACT

The invention is directed to a method for the removal of ATM cells (2, 6) from an ATM communications device wherein ATM cells (2, 3, 5, 6) are respectively allocated in pluralities to a common frame (8, 9), whereby all ATM cells (2...6) of a frame (9) whose first ATM cell (2) is in the waiting list (1) are removed from a waiting list (1) for the administration of a sequence of ATM cells (2, 3, 4, 5, 6).

In particular, the method makes it possible to quickly and efficiently create space for cells having a higher priority in the ATM communications device.

Fig. 1

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IN THE UNITED STATES ELECTED OFFICE
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UNDER THE PATENT COOPERATION TREATY-CHAPTER II

"**SUBMITTAL OF DRAWINGS**"

APPLICANT: HEISS et al.

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INVENTION: METHOD FOR THE REMOVAL OF ATM CELLS FROM AN ATM COMMUNICATIONS DEVICE

Hon. Assistant Commissioner for Patents
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Washington D.C. 20231

SIR:

Enclosed are copies of the two sheets of drawings showing Figures 1 and 2 as filed.

Respectfully submitted,

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ATTORNEY FOR APPLICANT

FIG 1

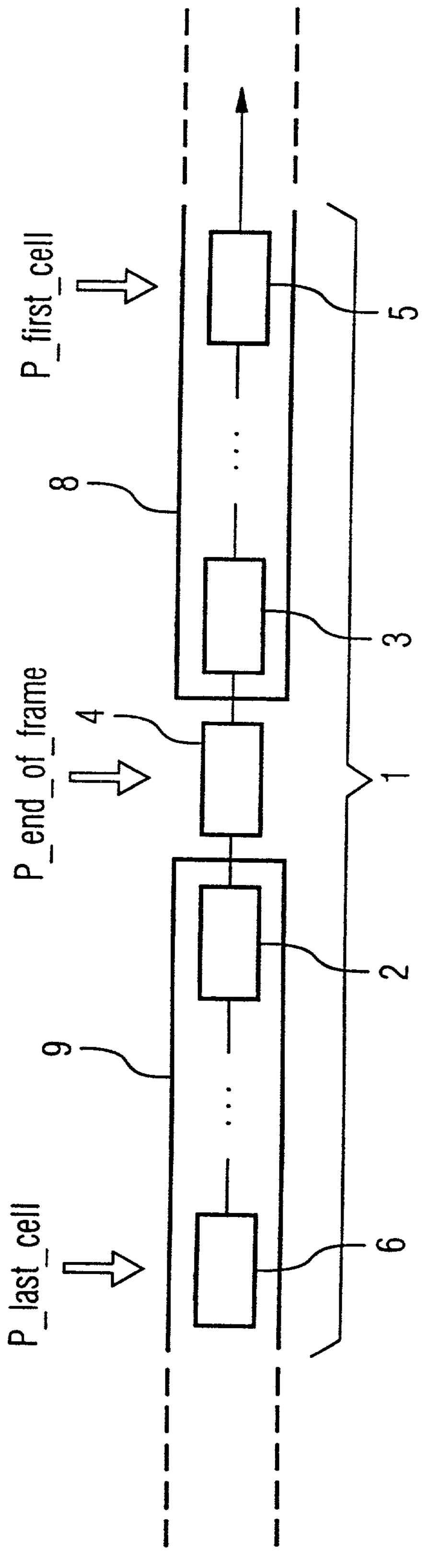
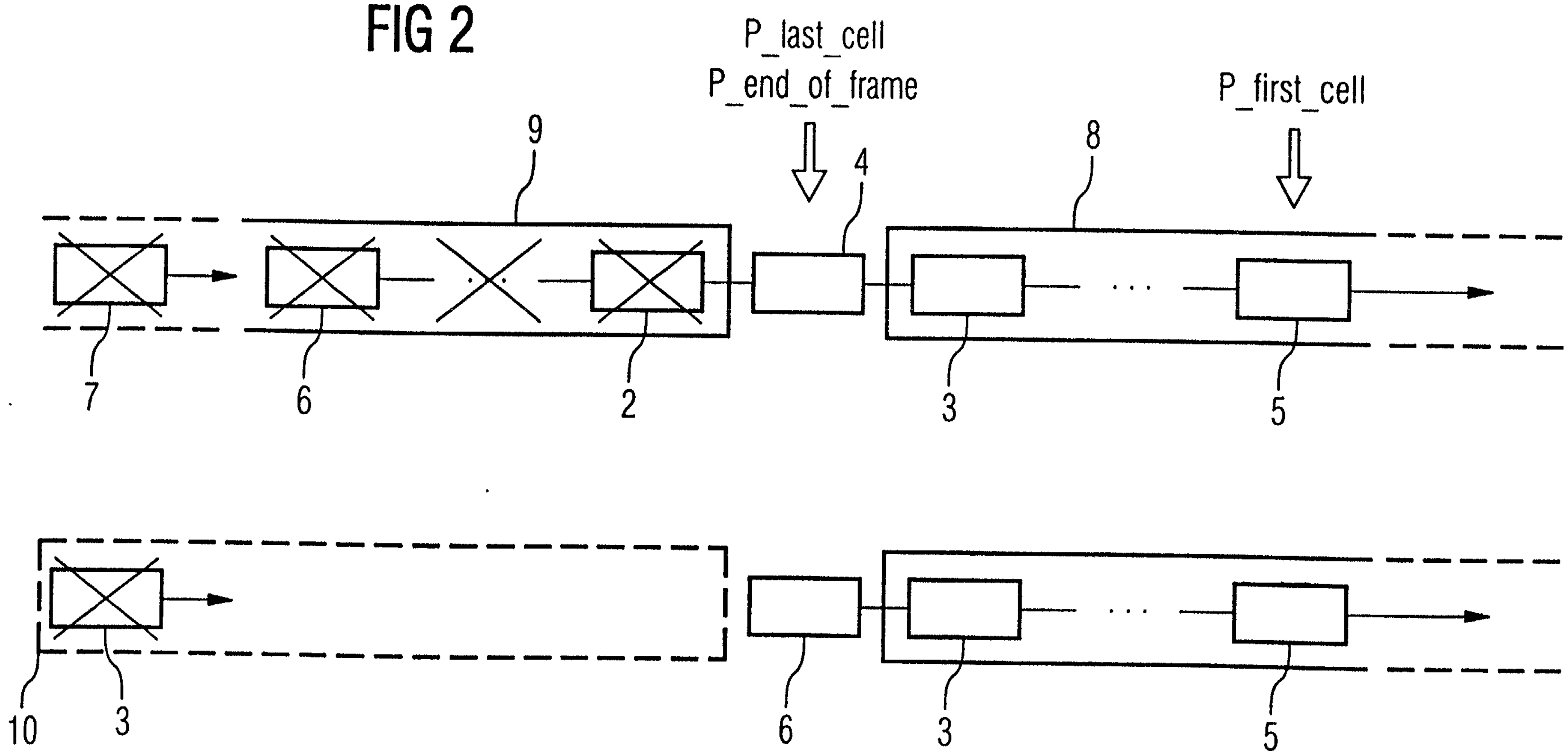


FIG 2



Declaration and Power of Attorney For Patent Application

Erklärung Für Patentanmeldungen Mit Vollmacht

German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:	As a below named inventor, I hereby declare that:
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Verfahren zum Entfernen von ATM-Zellen aus einer ATM-Kommunikationseinrichtung	________________
deren Beschreibung	the specification of which
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Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.	I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

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Prior foreign appplications
Priorität beansprucht

Priority Claimed

198 10 058.2	Germany	09. März 1998	☒	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
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(Application Serial No.) **(Anmeldeseriennummer)**	**(Filing Date)** **(Anmeldedatum)**	**(Status)** **(patentiert, anhängig, aufgeben)**	**(Status)** **(patented, pending, abandoned)**

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POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

And I hereby appoint

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(Supply similar information and signature for third and subsequent joint inventors).

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